Changes in the Epidemiologic Profile of Sudden Infant Death Syndrome as Rates Decline Among California Infants: 1990-1995

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ABSTRACT. *Objectives.* To evaluate changes in the rates and epidemiologic patterns of sudden infant death syndrome (SIDS) after implementation of public health campaigns to promote back sleeping and reduce exposure to cigarette smoke and environmental risk factors for SIDS.

Methods. California vital statistics data were used to evaluate changes in SIDS rates (deaths/1000 live births) and in the proportions of SIDS deaths by age and season of occurrence for California infants of black or other races from 1990 through 1995.

Results. From 1990 through 1995, 3508 SIDS deaths occurred. SIDS rates declined from 2.69 to 2.15 for black infants and from 1.04 to 0.61 for others between 1990 and 1995. Most SIDS deaths occurred during the 2nd to 4th months of life; the proportion of SIDS deaths during this period was unchanged for blacks but decreased for others from 70% to 65%. Of all SIDS deaths, 62% occurred during the colder season (October through March); the proportion of deaths in each season did not change for either race.

Conclusion. California SIDS rates declined 20% for blacks and 41% for others between 1990 and 1995. Declines coincided with campaigns to reduce environmental risk factors for SIDS. Blacks continue to be at increased risk for SIDS compared with others, and the SIDS rate for blacks relative to others has increased. Reductions in SIDS mortality coinciding with interventions were smaller for blacks than for others. New strategies are needed to reduce further SIDS rates and narrow the gap between blacks and others. *Pediatrics 1998;102: 1445-1451; sudden infant death syndrome, infant mortality.*

ABBREVIATIONS. SIDS, sudden infant death syndrome; ICD-9, International Classification of Diseases, 9th Revision.

infant death syndrome (SIDS) is the sudden death of an infant younger than 1 year of age that remains unexplained after completion of postmortem investigation, including an autopsy, examination of the scene of death, and review of the clinical history.[1] SIDS is the leading cause of postneonatal mortality in California [2] and in the United States.[1]

SIDS deaths follow a recognized epidemiologic pattern. They are most likely to occur in the colder months and in the 2nd to 4th months of life [1,4-6] Environmental factors associated with an increased risk for SIDS include prone positioning for sleep.[7-10] exposure to cigarette smoke during gestation or after birth [11-14] overheating,[7,15] and not breastfeeding.[7] Rates of SIDS in the United States have been higher for black infants than for white, Hispanic, and Asian infants [1,16] In California, public health measures related to SIDS were initiated during the early 1990s and continued to be implemented beyond 1995. Autopsy and death scene protocols, including medical history, were developed by an expert committee and implemented after legislative mandate to help standardize the diagnosis of SIDS. Public education campaigns focusing on reduction of environmental risk factors for SIDS, such as prone positioning and exposure to cigarette smoke, were carried out. The changes in SIDS rates over this period of interventions have not been evaluated previously.

Using data from California vital statistics changes in the rate and epidemiologic patterns of SIDS in California from 1990 through 1995 by infant's race have been evaluated. Examination of changes in the patterns of SIDS during this 6-year period of public health interventions may indicate the impacts of ongoing strategies to reduce SIDS mortality, identify directions for new strategies, and determine whether gaps in SIDS mortality continue to exist between population groups In California.

METHODS

Data for evaluation of SIDS rates were obtained from California birth and death records. The number of live births to California women was obtained from tapes of birth certificate data. Cause of death, dates of birth and death, and infant race were obtained from tapes of death certificate data for infants residing in California. SIDS deaths were identified by the International Classification of Diseases, 9th Revision, (ICD-9) code 798.0. Seventy-two deaths attributed to epiglottitis on the death certificate (ICD-9 code 464.3) also were considered to be SIDS deaths. Reclassification of these deaths was recommended by California SIDS experts and by the Centers for Disease Control and Prevention after a joint review of infant deaths attributed to epiglottitis in one California county by the Centers for Disease Control and Prevention, the California Department of Health Services, and the county health department.

SIDS death rates were calculated as the number of SIDS deaths during the first year of life per 1000 live births to California women. Rates were evaluated by race of infant and by year from 1990 through 1995. Race was limited to two categories, black

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. infants and infants of other racial/ethnic backgrounds, to minimize misclassification that may be associated with use of race/ethnicity data from the death certificate.17 Within each race group, the incidence of SIDS by age at death and season of death was described by year from 1990 through 1995 and changes m the proportion of SIDS deaths by age and season of death were evaluated over this period by using the χ^2 test for linear trend." Changes in the proportion of early SIDS deaths (during the 1st month of life), late SIDS deaths (after the 6th month of life), and SIDS deaths in the ages of peak SIDS occurrence (between the 2nd and 4th months of life) were evaluated, as well as changes in the proportion of SIDS deaths m colder months versus warmer months. Analyses were performed using SPSS19 and Epi-Info.20

RESULTS

From 1990 through 1995, 3 524 475 live births and 3508 SIDS deaths occurred among California women. Of these deaths, 62% were male infants. Eight percent of the infants born and 19% of the infants who died from SIDS were black. SIDS rates declined 20% for blacks from 2.69 to 2.15, with the greatest decline occurring between 1991 and 1992 (Fig 1). Rates declined 41% from 1.04 to 0.61 for infants of other races, with sustained decline after 1991. As a result, the ratio of rates for black infants compared with that for others rose from 2.6 in 1990 to 3.5 m 1995, indicating a widening gap between SIDS rates for black infants and others (Table 1).

The greatest number of SIDS deaths occurred during the 2nd to 4th months of life and declined through the subsequent months in each year (Figs 2, 3). The proportion of SIDS deaths between the 2nd and 4th months of life decreased from 67% to 63% for black infants between 1990 and 1995. Although there was a decrease of 4% for black infants, the proportion of deaths during this peak period did not change consistently each year, as shown m Fig 2, and the χ^2 test for linear trend over this 6-year period was not significant ($P > .05$). The proportion of deaths during the 2nd to 4th months decreased from 70% to 65% for the other group of infants between 1990 and 1995. For this group, there was a linear trend of decline in the proportion of deaths occurring between the 2nd and 4th months over the 6-year study period that was significant when evaluated by using the χ^2 test for linear trend ($P < .05$).

The small annual number of very early (during the Ist month) and very late (after the 6th month) SIDS deaths precluded meaningful evaluation of changes in the proportion of these deaths among black m-fants. Among other infants, although the number and proportion of SIDS deaths that occurred in the 1st month of life declined between 1990 and 1995, the trend for change m the proportion over time was not significant. In contrast, the number of very late SIDS deaths remained relatively stable for this group of infants from 1990 through 1995. As a result, the proportion of all SIDS deaths after the 6th month increased significantly from 7% to 12% during the study period, as evaluated using the χ^2 test for linear trend ($P < .001$).

Sixty-three percent of all SIDS deaths among black infants and 62% of all SIDS deaths among other infants during 1990 to 1995 occurred in the colder months (October through March) compared with the warmer months (April through September). Overall, reduction m the number of SIDS deaths between 1990 and 1995 was 1.5 and 1.9 times greater in the colder months than in the warmer months for black and other infants, respectively (Figs 4, 5). When evaluated by 6-month seasons, the proportion of SIDS deaths in the colder season did not change significantly for either group of infants, as determined by the χ^2 test for linear trend ($P > .05$). Changes in the number of SIDS deaths in each quarter of the year between 1990 and 1995 suggest no clear change m the seasonality of SIDS deaths among black infants (Fig 4), but imply attenuation of the seasonality among other infants (Fig 5).

DISCUSSION

SIDS rates in California declined 20% for black infants and 41% for others during 1990 to 1995. Coinciding with the decline m SIDS rates, postneonatal mortality rates have declined 15% for black infants

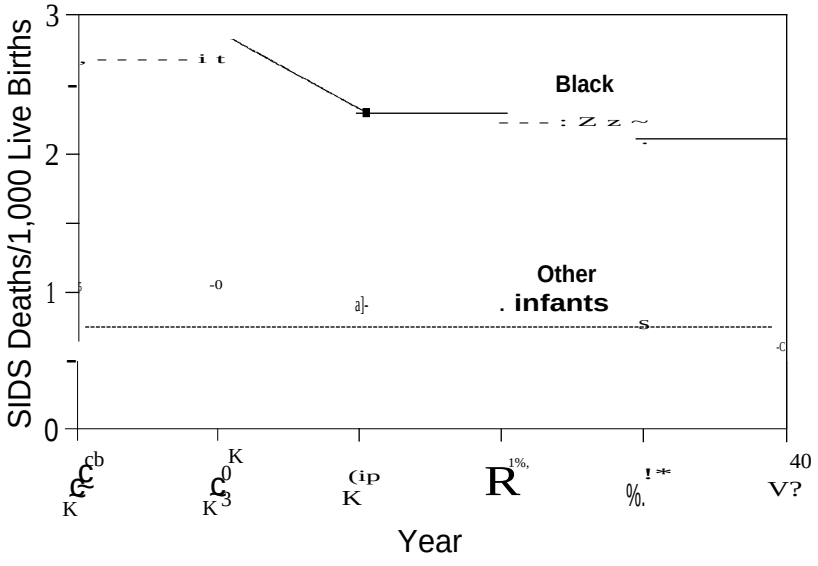

Fig 1. SIDS rates by infant race, 1990-1995. SIDS deaths were identified by ICD-9 code 798.0. SIDS rates are deaths/1000 live births. Rates were evaluated for infants of black *(n* = 637) and other races *(n* 2799). Race of infants dying was determined by race as recorded on death certificate. Race for live-born infants was determined by race of mother as recorded on birth certificate.

• TABLE 1. Number of Cases and Rates* of SIDSt by Racel of Infants (0-364 Days Old), 1990-1995

	Race						
	Black		Other		All Infants		Rate Ratio, Black/Other
Year	Number	Rate	Number	Rate	Number	Rate	
1990	131	2.69	587	1.04	718	1.17	2.58
1991	135	2.84	593	1.06	728	1.19	2.69
1992	106	2.29	495	0.89	601	1.00	2.57
1993	101	2.26	476	0.88	577	0.99	2.56
1994	89	2.10	398	0.76	487	0.86	2.77
1995	86	2.15	311	0.61	397	0.72	3.53
Total	648	2.40	2860	0.88	3,508	1.00	2.74

* Per 1000 live births.

t SIDS deaths identified by lCD-9 code 798.0. Epiglottitis (ICD-9 code 464.3) deaths were also considered to be SIDS deaths.

T Race for infants dying of SIDS was determined by race recorded on death certificate; race for live-born infants was determined by race of mother as recorded on birth certificate.

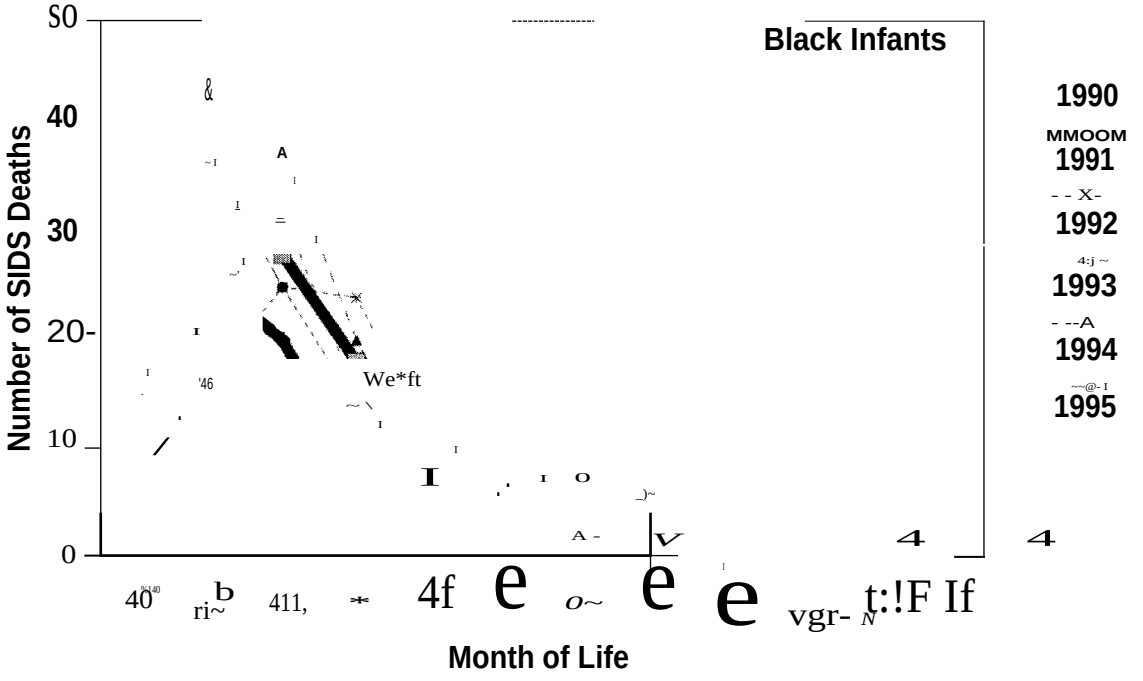

Fig 2. Number of cases of SIDS in each month of life among black infants, 1990 -1995: 1990, *n* 131; 1991, *n* 135; 1992, *n* 106; 1993, *n* 101; 1994, *n* 89; 1995, *n* 86.

and 23% for others over this period. The decline in SIDS death rates have made a substantial contribution to the declines in postneonatal mortality, accounting for 66% of the decrease in black postneonatal mortality and 63% of the decrease for others. Declines in SIDS mortality have paralleled declines in postneonatal infant mortality over this period for black and other infants.

Reductions in SIDS mortality occurred during a period of national and statewide efforts to reduce the exposure of infants to environmental risk factors for SIDS and to standardize the diagnosis of SIDS. The California Tobacco Control Program was implemented m 1989 to promote smoking reduction m adults." In 1991, California legislation was implemented mandating the use of standard death scene investigation and autopsy protocols for all unexplained infant deaths to improve consistency in identification of SIDS deaths. Statements by the American Academy of Pediatrics u-i 19929 and 1994 22 promoting back- or side-sleeping for infants were conveyed to the public by health practitioners and the media. After these statements were issued, California's Back to Sleep campaign was launched m 1994. This campaign promotes nonprone sleeping positions for m-fants and reduction of other environmental risk factors for SIDS. Although the effects of interventions were not evaluated m this study, changes observed in the rates of SIDS mortality are consistent with positive impacts of interventions.

Declines in SIDS rates cannot be explained by shifts in the classifications of SIDS deaths to other causes after implementation of the death scene m-vestigation and autopsy protocols m 1991. Autopsy rates have remained stable over this period for black and other infants at 98% to 100%. Postneonatal mortality associated with the combined categories of accidents and adverse effects, influenza and pneumonia, interstitial pneumonitis, respiratory distress syndrome, or undetermined causes decreased be-

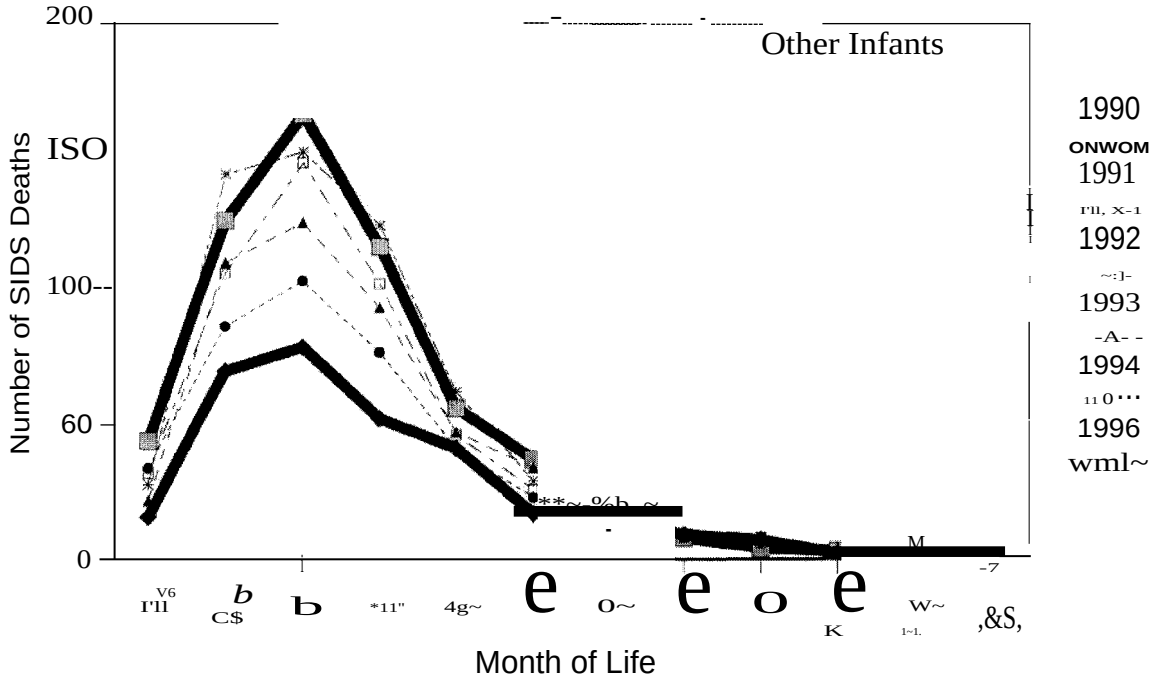

Fig 3. Number of cases of SIDS in each month of life among other infants: 1990 -1995: 1990, n 587; 1991, n 593; 1992, n495; 1993, n 476; 1994, n 398; 1995, n 311.

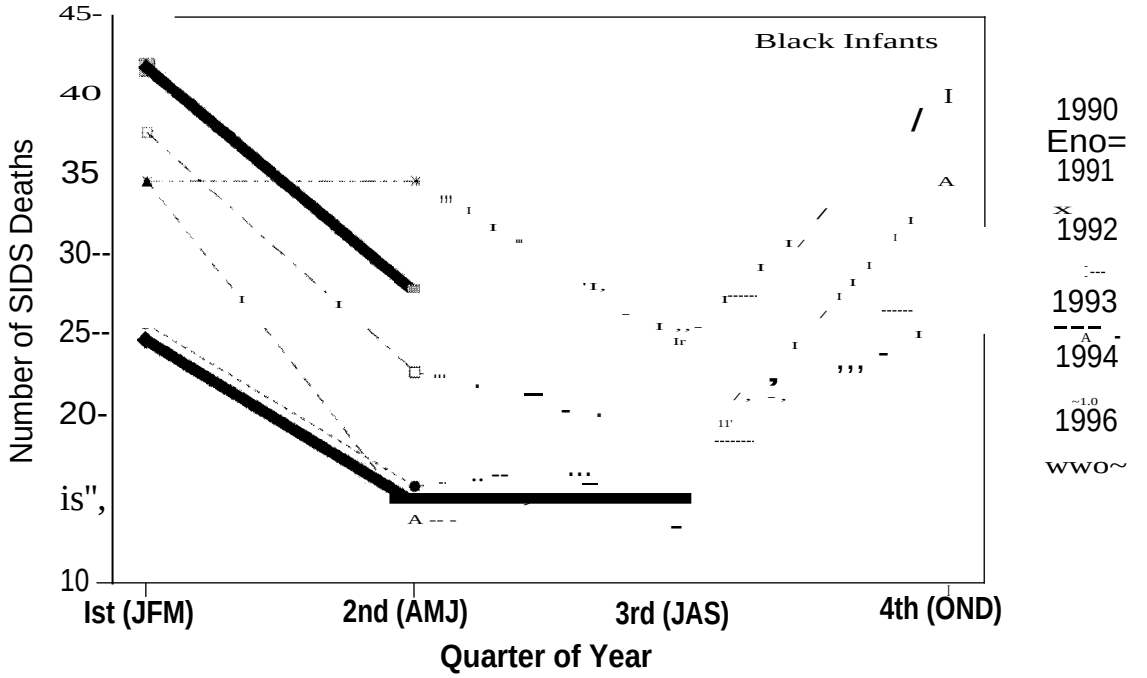

Fig 4. Number cases of SIDS in each quarter of the year for black infants, 1990-1995: 1990, *n* = 131; 1991, n = 135; 1992, n 106; 1993, *n* 101; 1994, n 89; 1995, n 86.

tween 1990 and 1995 for black and other infants, as shown in Table 2. Misclassification of SIDS deaths into any one or any combination of these cause of death categories could not explain the decreases observed in SIDS mortality for either race group. Therefore, the declines m SIDS rates observed do not appear to be an artifact of misclassification. of SIDS deaths into other causes of death. This finding supports the conclusion that there has been a true decline in SIDS rates between 1990 and 1995.

The percentage of California infants positioned on their backs for sleep has increased over the period m which back-sleeping has been promoted. Results of surveys of California households with infants younger than 8 months of age show that back-sleeping has increased from 19% to 38% between 1992 and

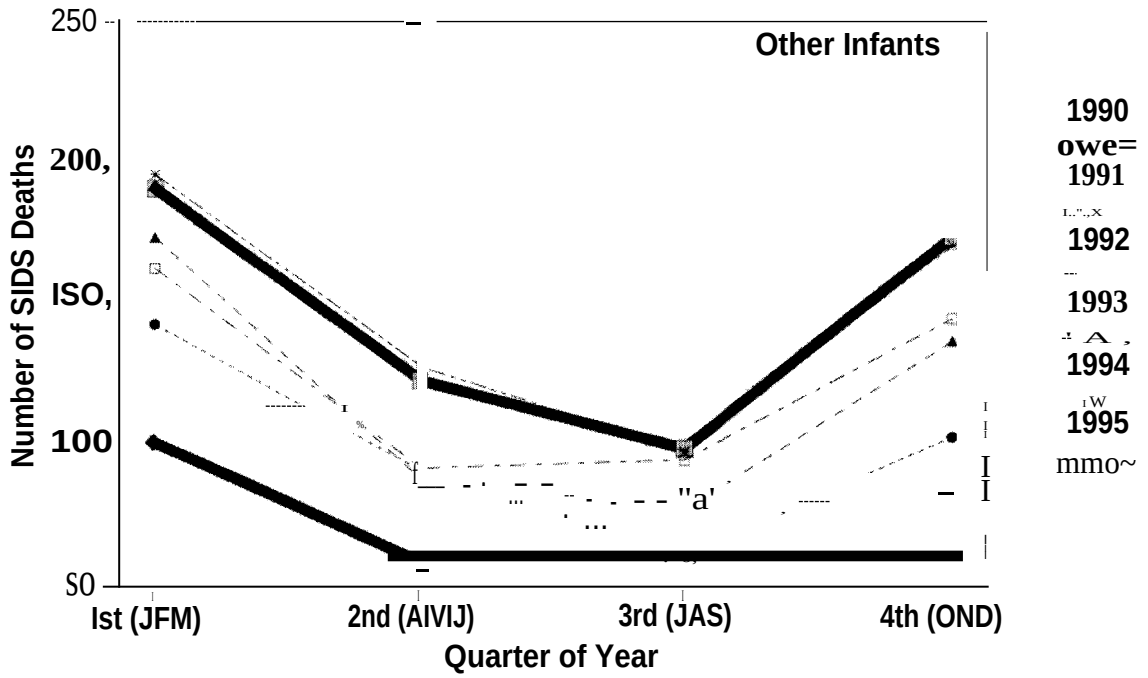

Fig 5. Number of cases of SIDS in each quarter of the year for other infants, 1990-1995: 1990, *n* = 587; 1991, *n = 593*; 1992, *n = 495*; 1993, n 476; 1994, n 398; 1995, n : 311.

TABLE 2. Cause-specific Postneonatal Mortality Rates* by Racet of Infant, 1990-1995

Cause of death (ICD-9 Codes)	Other Infants		Black Infants	
	Year		Year	
	1990	1995	1990	1995
Congenital anomalies (740-759)	0.51	0.42	0.70	0.75
SIDS (798.0)	0.97	0.59	2.63	1.97
Respiratory distress syndrome (769)	0.04	0.02	0.06	0.18
Accidents/ adverse effects (E800-E949)	0.13	0.09	0.25	0.35
Pneumonia/influenza (480-487)	0.12	0.10	0.33	0.18
Interstitial pneumonitis (516.8)	0.04	0.02	0.21	0.00
Undetermined (799.9)	0.09	0.10	0.25	0.28
Other causes	0.85	0.79	2.22	1.95
Total	2.75	2.13	6.63	5.65

* Per 1000 live births.

t Race for infants dying of SIDS was determined by race recorded on death certificate; race for live-born infants was determined by race of mother as recorded on birth certificate.

1995.11 Similarly, surveys of households in the United States, including California households, show that the percentage of infants younger than 8 months of age put to sleep in prone positions dropped from 70% to 24% between 1992 and 1996.24 Although prone sleeping prevalence declined in all groups in this national study, the decline was smaller among black infants. As a result of these shifts, a greater proportion of black infants in the United States, compared with others, were put to sleep m the prone position during this period. Findings from these studies make it plausible that shifts to back-sleeping may have contributed to the reduction in SIDS mortality.

Similarly, reductions in the prevalence of smoking m California between 1990 and 1995 were consistent with the reductions observed in SIDS rates, and it is plausible that declines in smoking also may have contributed to the declines in SIDS mortality. Smoking prevalence among non-Hispanic black adults fell markedly between 1990 and 1992, from 28% to 21%, and then remained fairly stable through 1995 when prevalence also was 21%." The prevalence of smoking among adults of other racial/ethnic groups showed a more gradual, continuous decrease from 20% in 1990 to 16% m 1995 .21 The declines in SIDS rates reported in this study have followed a pattern that is similar to the declines m smoking prevalence. (Smoking prevalence data were not available for either group m 1991.) Although observations suggest that declines in California's SIDS rates have been associated temporally with statewide declines in smoking prevalence, they are based on data aggregated at the state level and cannot be extrapolated to the individual level.

Small statistically significant change in the age pattern of SIDS occurrence and a suggestion of attenuation m the seasonal pattern of SIDS was found among infants who were not black. The number of SIDS deaths and the decline m SIDS rates were smaller for black infants than for others, and this may be part of the reason that changes in the age and seasonal patterns of SIDS were not identified in black infants. This is the first report of changes in the age and seasonal patterns of SIDS from the United States. However, changes in seasonal patterns have been reported in countries that implemented campaigns to reduce environmental risks earlier than did the United States and in which shifts to mostly nonprone sleeping position have been documented .7,15

. Findings that the proportion of late SIDS deaths increased between 1990 and 1995 suggests that the determinants of these deaths may differ from those in the earlier SIDS deaths. The pathophysiology of SIDS deaths m the 1st month and after the 6th month of life may differ from those occurring between the ages of 30 and 180 days. During the first half of infancy, rapid central and autonomic nervous system myelination and maturation accompany dramatic changes in the neurologic control of breathing, cardiac function and sleep/wake cycles .16 This finding also suggests that current strategies may not have been as effective in reducing SIDS deaths in infants older than 6 months of age compared with younger infants. Although shifts observed in the age of SIDS occurrence are small, they are important because they may suggest early changes in recognized patterns of SIDS risk. Changes in the proportion of late infant deaths associated with SIDS and other causes of death are shown in Table 3 for other infants. Although the proportion of all non-SIDS deaths after 6 months decreased over this time, much of this decrease was driven by a decline in the proportion of late deaths associated with congenital anomalies. The proportion of late infant deaths associated with accidents and adverse effects, respiratory distress syndrome, pneumonia and influenza, and other undetermined causes remained stable or increased over this period, suggesting that the increase m proportion of late SIDS deaths observed between 1990 and 1995 was not caused by diagnostic error. Additional study will be needed to determine whether these changes persist or are amplified as interventions to reduce exposure to risk factors for SIDS continue.

Because specific indicators of social conditions, cultural practices, and environmental factors were not available from the death certificate data used m this study, infant race was used as a proxy for these factors. Although race is limited as an indicator of social conditions, findings may be useful for targeting of intervention efforts by programs, such as the California Black Infant Health Program, that targets black communities to reduce infant mortality. Race misclassification is a concern because race data were obtained from death certificates .17 Death certificates may be completed without family review and thus the race recorded may not be consistent with the race that would be identified by a family member. However, it is likely that misclassification would lead to underestimation of the differences m rates between black and other infants and, therefore, cannot explain study findings. Although use of data from linked birth and death certificate files would have provided additional information about infant and family characteristics and helped to reduce race misclassification, the availability of linked California data lags 2 to 3 years behind the availability of death certificate data. This makes use of linked data impractical for evaluation of the most recent changes m SIDS mortality.

Differences in the magnitude and timing of the decline m SIDS rates between blacks and other infants raise questions about strategies for continued SIDS reduction for both groups. Differences m SIDS reduction between groups may be related to differences in the effectiveness of public health messages promoting reduction of risk factors or to differences in the distribution of risk factors between groups. As shifts to nonprone sleep positions occur, the relative importance of other risk factors can be expected to increase. Additional work is needed to reevaluate the most important indicators of risk for each group and to identify the most effective intervention strategies.

TABLE 3. Deaths Occurring After 6 Months of Age for Other* Infants, 1990 and 1995

Cause of Death (ICD-9 Codes)	Percentage of Deaths Occurring After 6 Months of Age	
	1990	1995
SIDS (798.0)	6.8	11.6
All non-SIDS deaths	8.9	8.2
Selected categories of non-SIDS Deaths		
Congenital anomalies (740-759)	7.8	5.7
Respiratory distress syndrome (769)	1.8	5.3
Accidents/ adverse effects (E800-E949)	48.8	48.0
Pneumonia/ influenza (480-487)	14.1	20.6
Interstitial pneumonitis (516.8)	13.8	0
Undetermined (799.9)	14.9	18.2
All infant deaths	8.5	8.6

* Race for infants dying of SIDS was determined by race recorded on death certificate and categorized as black or other.

CONCLUSION

From 1990 through 1995, SIDS rates in California declined 20% for black infants and 41% for infants who were not black. This decline coincided with national and statewide efforts to reduce the exposure of infants to environmental risk factors for SIDS. However, black infants continue to be at increased risk for SIDS compared with others, and the ratio of SIDS rates for black infants relative to others has increased during the 6-year period. Overall, intervention efforts have been associated temporally with smaller declines in SIDS mortality in black infants than among others, especially after 1992. Improved strategies are needed to reach care providers of black infants effectively. California is now developing more culturally sensitive SIDS education materials and strategies for dissemination. Continued research to identify changes in patterns of risk and to identify new risk factors is essential for future development of strategies to reduce further SIDS deaths and to narrow the gap between black infants and others.

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WHERE'S THE BEEF?

I am convinced that the volume of pertinent new information that finally becomes available each year-the meaty stuff that a physician needs to know to provide optimal care to his patients-is not overwhelming. It is finite; it is tractable. But it is difficult to pin down. The problem lies In separating the wheat from the incredible amount of chaff.

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